

**WHAT IS CLAIMED IS:**

1. A composite structure comprising a coated element, and at least one fiber optic condition sensor embedded physically within a coating of said coated element, wherein said sensor detects a condition of said composite structure.

2. The structure of claim 1, wherein at least one said fiber optic condition sensor senses a strain or temperature condition of said wire assembly

3. The structure of claim 1, wherein said coating is a polymeric coating, and wherein said element is an electrical conductor.

4. The structure of any one of claims 1-3, wherein said at least one fiber optic condition sensor comprises a series of axially spaced apart Bragg gratings written therein.

5. The structure of claim 1, comprising a plurality of said fiber optic condition sensors each embedded in said coating.

6. The structure of claim 5, wherein each of said fiber optic condition sensors comprises a series of axially spaced apart Bragg gratings written therein.

7. The structure of claim 5 or 6, wherein at least one of said fiber optic condition sensors detects a strain condition of said structure, and wherein at least one other fiber optic sensor detects a temperature condition of said structure.

8. The structure of claim 1, wherein the coating is a magnetorestrictive coating, and wherein said sensor detects strain of said coating in a magnetic field.

9. A condition detection system comprising a composite structure as in claim 1, a data acquisition system operatively connected to said fiber optic sensor for outputting a signal indicative of a predetermined condition of said structure, and a monitor for receiving the signal and providing an indication of said predetermined condition.

10. The system of claim 9, wherein said monitor provides a visual and/or aural indication of said predetermined condition.

11. The system of claim 9, wherein said monitor stores data associated with said predetermined condition.

12. A wire assembly having integral condition detection capabilities, comprising:

- a wire element which includes at least one electrical conductor;
- an electrical insulator surrounding said wire element; and
- a fiber optic condition sensor in operative association with said electrical insulator to detect a condition of said wire assembly.

13. The wire assembly as in claim 12, wherein said fiber optic condition sensor is embedded physically within said electrical insulator.

14. The wire assembly as in claim 12, wherein said wire element includes a plurality of electrical conductors, and wherein said fiber optic condition sensor is associated physically with said plurality of electrical conductors so as to be surrounded by said electrical insulator.

15. The wire assembly as in claim 12, wherein said fiber optic condition sensor senses a strain condition or temperature condition of said wire assembly.

16. The wire assembly of claim 12, comprising a plurality of fiber optic condition sensors each in operative association with said electrical insulator and each having a series of axially spaced apart Bragg gratings written therein for detecting strain on the electrical insulator.

17. The wire assembly of claim 12, wherein the fiber optic condition sensor is oriented substantially parallel to or spirally wound around the electrical conductor.

18. The wire assembly of claim 12, wherein the electrical insulator is a polymeric material.

19. The wire assembly of claim 18, wherein the polymeric material is extruded as a coating onto the electrical conductor.

20. The wire assembly of claim 18, wherein the polymeric material is a heat-shrunk tube, tape wrap or woven sleeve.

21. The wire assembly of claim 18, wherein the polymeric material is a polyolefin, polytetrafluoroethylene, fluorinated ethylene propylene, polyvinylidene fluoride, ethylene-tetrafluoroethylene, or polyimide.

22. The wire assembly of claim 21, wherein the polymeric material is a heat shrunk tube, tape wrap or woven sleeve.

23. An insulation wear detector system comprising a wire as in claim 11, a data acquisition system operatively connected to said fiber optic sensor for outputting a signal indicative of a predetermined change in strain of the electrical insulator, and a monitor for receiving the signal and providing an indication of said predetermined change in strain.

24. The system of claim 23, wherein said monitor provides a visual and/or aural indication of said predetermined change in strain.

25. A method of making a wire assembly having an integral fiber optic-based insulation wear detector, said method comprising the steps of:

- (a) providing a fiber optic sensor having a series of axially spaced apart Bragg gratings written therein;  
and
- (b) operatively associating the fiber optic sensor with an electrical insulator coating which surrounds an electrical conductor.

26. The method of claim 25, wherein step (b) comprises embedding the fiber optic sensor in the electrical insulator coating.

27. The method of claim 26, wherein step (b) comprises extruding the electrical insulator onto the electrical conductor simultaneously while embedding the fiber optic sensor in the electrical insulator.

28. The method of claim 25, wherein step (b) comprises (i) associating the fiber optic sensor with a heat shrinkable tape or tubing, (ii) placing the heat shrinkable tape or tubing around the electrical conductor, and (iii) subjecting the tape or tubing to heat shrinkage.

29. The method of claim 25, wherein step (b) comprises (i) extruding the electrical insulator coating and (ii) associating the fiber optic sensor with the coating, (iii) subjecting the extruded coating to curing and/or cooling.

30. The method of claim 25, wherein step (b) comprises (i) wrapping a tape of the electrical insulator around the conductor, and (ii) associating the fiber optic sensor with the tape.

31. The method of claim 30, wherein the fiber optic sensor is associated with the tape prior to wrapping.

32. The method of claim 25, wherein step (b) comprises (i) associating the fiber optic sensor with a woven sleeve, and (ii) placing the woven sleeve over the conductor.

33. The method of claim 25, wherein a plurality of said fiber optic sensors are associated operatively with said electrical insulator.

34. A method of detecting a condition of a coating on an element in need of condition detection, said method comprising the steps of:

- (i) embedding at least one fiber optic condition sensor within the coating; and
- (ii) spectrally analyzing the fiber optic condition sensor to detect a condition of the coating.

35. The method of claim 34, wherein said fiber optic condition sensor has a series of axially spaced apart Bragg gratings written therein, and wherein step (ii) comprises detecting a change in the reflected light wavelength of at least one of the Bragg gratings written into the fiber optic condition sensor.

36. The method of claim 35, wherein step (i) comprises the step of causing the coating to induce stress on the Bragg gratings of the fiber optic condition sensor thereby establishing a normal light wavelength reflection condition for the Bragg gratings.

37. The method of claim 36, wherein the insulator induces stress on the Bragg gratings sufficient to cause a change in reflected light wavelength which is greater than about 0.1 nm.

38. The method of claim 37, wherein the insulator induces stress on the Bragg gratings sufficient to cause a change in reflected light wavelength which is between about 1.0 nm to about 4.0 nm.

39. The method of claim 37, wherein the insulator induces stress on the Bragg gratings sufficient to cause a change in reflected light wavelength which is between about 2.2 nm to about 2.6 nm.

40. The method of claim 35, wherein step (ii) comprises detecting at least a partial relief of the stress induced by the insulator coating which is indicative of wear and/or damage to the insulator coating.

41. The method of claim 34, wherein step (i) comprises the step of embedding a plurality of said fiber optic sensors within said coating.

42. The method of claim 34, wherein the coating is a polyolefin, polytetrafluoroethylene, fluorinated ethylene propylene, polyvinylidene fluoride, ethylene-tetrafluoroethylene, or polyimide.

43. The method of claim 34, wherein the coating condition is monitored periodically or continuously.